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9. FINANCIAL QUALIFICATIONS

Hughes Communications Inc. is an indirect wholly-owned subsidiary of Hughes Electronics Corporation (HE), a large aerospace, electronics manufacturing, and satellite communications company. HE, in turn, is an affiliate of General Motors Corporation (GM). As demonstrated in Appendix D, containing the consolidated financial statements of HE, HE has sufficient current assets to fund the construction, launch, and first-year operating costs of the SpaceCast™ satellite system.

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10. ENGINEERING CERTIFICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's Rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.

By: Daniel P. Sullivan

Daniel P. Sullivan, Ph.D.
Vice President, Engineering
Hughes Communications, Inc.
September 24, 1997

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Certifications

11. WAIVER AND CERTIFICATIONS

In accordance with Section 304 of the Communications Act of 1934, as amended, 47 U.S.C. 304, HCI hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

HCI certifies that neither the Applicant nor any of its shareholders, nor any of its officers or directors, nor any party to this application is subject to a denial of Federal benefits pursuant to authority granted in Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. § 862.

The undersigned certifies individually and for HCI that all of the statements made in this Application are true, complete, and accurate to the best of his information, belief and knowledge, and are made in good faith.

Respectfully submitted,

Hughes Communications, Inc.

By: _____

Gerald F. Farrell

President

September 24, 1997

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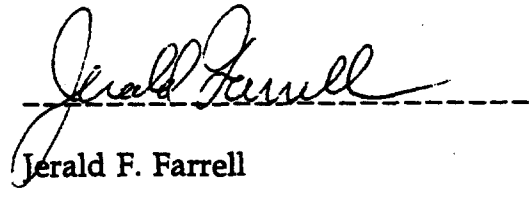
Conclusion

12. CONCLUSION

For the reasons set forth in this Application, HCI respectfully requests that the Commission promptly grants this application to enable HCI to bring to the public the significant benefits described above at the earliest possible time.

Respectfully submitted,

Hughes Communications, Inc.

By: 

Jerald F. Farrell
President
September 24, 1997

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Appendix A
Transmission Characteristics

APPENDIX A: TRANSMISSION CHARACTERISTICS

SpaceCast™ link budget information is provided in Tables A-1 thru A-6. The RF communication links include the following: V-band, Ku-band, satellite telemetry, and satellite command. Uplinking sites will use 2.5 meter terminals (V-band and Ku-band). Dual band receive terminals (V-band and Ku-band) will be 1 meter (39 inches). User terminals as small as 45 cm (18 inches) can also be used for receive only service at a lower data rate. The satellite ground stations use 7-meter antennas for telemetry and command.

In all cases, the link budget calculations place the transmitting terminal of interest at the satellite antenna beam edge. All cases show a positive margin at the indicated availability values.

The V-band link budgets are given in Tables A-1-a and b and A-3-a and b. Table A-1-a contains the link for a 1 meter receive terminal, and Table A-1-b contains the link for a 45 cm receive terminal. A New York City uplink to Boston downlink was picked as being representative of the links that SpaceCast™ will provide. In both cases, a 2.5 meter uplink terminal with a 50 Watt HPA can generate an uplink EIRP of 73.0 dBW under clear conditions and 75.5 dBW under rain conditions. The satellite EIRP per carrier is 62.0 dBW. The link margin of 0.0 dB (or 0.1 dB) for clear-sky uplink and rainy downlink conditions indicates that the specified link availability objective can be met; the same is true for all link budgets presented in this Appendix. Budgets for a Tokyo uplink to Honolulu ground relay and on to Seattle are provided in Tables A-3-a and b. The link budgets show 10 carriers uplinked from a 2.5 meter ground terminal. Both Tokyo and Honolulu uplink

EIRPs per carrier are 63.0 and 65.5 dBW (50 Watt HPA) under clear and rain conditions, respectively. The satellite EIRP per carrier is 62.0 dBW.

Ku-band link budgets are given in Tables A-2, A-4-a, and A-4-b using 1° x 3° beams. A Miami uplink to New York City downlink was picked as being representative of the links that SpaceCast™ will provide at Ku-band. A 2.5 meter terminal with a 100 Watt HPA is used to provide an uplink EIRP of 67.5 dBW under clear conditions and 68.5 dBW under rain conditions. The satellite EIRP per carrier is 54.7 dBW. A Singapore uplink to Midway ground relay and further on to Seattle downlink also was picked. Singapore uplink EIRPs per carrier are 67.5 and 68.5 dBW (100 Watt HPA) under clear and rain conditions, respectively. Midway uses a 50 Watt HPA and provides uplink EIRPs per carrier of 64.5 and 65.5 dBW under clear and rain conditions, respectively. The satellite EIRP per carrier is 54.7 dBW.

Tables A-5 and A-6 contain information regarding the satellite telemetry & command links. Dry geographical regions are selected along with favorable elevation angles for the satellite operational control facilities to provide high reliability TT&C links. The telemetry and command links will use Ku-band frequencies for transfer orbit and on-station service.

Table A-1-a. V-Band Link: New York U/L to Boston D/L - 1 m Receive Terminal

SUMMARY of Uplink Budget				
Sat. Long. @ -60 deg East	**Clear**		**Rain**	**Units**
Terminal Location & Size:	**New York**	**2.5**		meter
Site Elevation Angle	40.8			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.70	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	2.5		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		73.0	75.5	dBW
Space Loss		217.7	217.7	dB
Atm. (Gas + Cloud) Att.		4.6	4.8	dB
Rain Attenuation			14.7	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		22.2	9.8	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		98.0	98.0	dB/Hz
Thermal U/L C/(No)		105.2	92.8	dB/Hz
Total D/L C/I	15.0			dB
D/L C/(Io)		98.0	98.0	dB/Hz
Thermal D/L C/(No)		95.0	90.3	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		**Rain**	**Units**
Terminal Location & Size:	**Boston**	**1.00**		meter
Site Elevation Angle	39.8			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			98.80	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.2	216.2	dB
Atm. (Gas + Cloud) Attenuation		2.6	2.8	dB
Rain Attenuation			3.4	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	50.8			dBi
System Noise Temp	448.1		581.8	°K
System Noise Temp	26.5		27.6	dBK
Station G/T		23.8	22.6	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		12.0	7.3	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	105.2	92.8	105.2	dB/Hz
U/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
U/L C/(No+Io) (dB/Hz	97.2	91.7	97.2	dB/Hz
D/L C/(No) (dB/Hz)	95.0	95.0	90.3	dB/Hz
D/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
D/L C/(No+Io) (dB/Hz	93.2	93.2	89.6	dB/Hz
Total C/(No+Io) (dB/Hz)	91.8	89.4	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	2.9	0.5	0.0	dB

Table A-1-b. V-Band Link: New York U/L to Boston D/L - 0.45 m Receive Terminal

SUMMARY of Uplink Budget				
Sat. Long. @ -60 deg East	**Clear**		**Rain**	**Units**
Terminal Location & Size:	**New York**	**2.5**		meter
Site Elevation Angle	40.8			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.70	%
Application Data Rate	26			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	2.5		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		73.0	75.5	dBW
Space Loss		217.7	217.7	dB
Atm. (Gas + Cloud) Att.		4.6	4.8	dB
Rain Attenuation			14.7	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		75.3	75.3	dBHz
C/N (Thermal)		29.9	17.5	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		90.3	90.3	dB/Hz
Thermal U/L C/(No)		105.2	92.8	dB/Hz
Total D/L C/I	13.4			dB
D/L C/(Io)		88.7	88.7	dB/Hz
Thermal D/L C/(No)		88.1	84.0	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	30			Mbps
Data Rate (dB)	74.7			dB (bps)
Required C/(No+Io)		81.2	81.2	dB/Hz

SUMMARY of Downlink Budget				
	Clear		**Rain**	**Units**
Terminal Location & Size:	**Boston**	**0.45**		meter
Site Elevation Angle	39.8			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			98.60	%
Link Data Rate	26			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff	2.0			dB
# of Amplified Carriers	10			
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.2	216.2	dB
Atm. (Gas + Cloud) Attenuation		2.6	2.8	dB
Rain Attenuation			2.9	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	43.8			dBi
System Noise Temp	448.1		568.9	°K
System Noise Temp	26.5		27.6	dBK
Station G/T		16.8	15.8	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		75.3	75.3	dBHz
C/N (Thermal)		12.8	8.7	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	105.2	92.8	105.2	dB/Hz
U/L C/(Io) (dB/Hz)	90.3	90.3	90.3	dB/Hz
U/L C/(No+Io) (dB/Hz	90.1	88.4	90.1	dB/Hz
D/L C/(No) (dB/Hz)	87.0	85.2	82.9	dB/Hz
D/L C/(Io) (dB/Hz)	88.7	88.7	88.7	dB/Hz
D/L C/(No+Io) (dB/Hz	84.8	83.6	81.9	dB/Hz
Total C/(No+Io) (dB/Hz)	83.7	82.4	81.3	dB/Hz
Required C/No (dB/Hz)	81.2	81.2	81.2	dB/Hz
Margin (dB)	2.4	1.1	0.1	dB

Table A-2. Ku-Band Link: Miami U/L to New York D/L - 1 m Receive Terminal

SUMMARY of Uplink Budget				
Sat.long. @ -60 deg East	Clear		Rain	Units
Terminal Location & Size:	Miami	2.5		meter
Site Elevation Angle	52.4			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.70	%
Application Data Rate	155			Mbps
Station Transmitter Power	100.0			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	1.0		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	48.8			dBi
Total EIRP per beam		67.5	68.5	
Operating EIRP per carrier		57.5	58.5	dBW
Space Loss		206.1	206.1	dB
Atm. (Gas + Cloud) Att.		0.3	0.3	dB
Rain Attenuation			3.9	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	33.5			dBi
System Noise Temp	365.1			°K
System Noise Temp	25.6			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		13.7	10.8	dB
Total U/L C/I	14.1			dB
U/L C/(Io)		97.1	97.1	dB/Hz
Thermal U/L C/(No)		96.7	93.8	dB/Hz
Total D/L C/I	10.4			dB
D/L C/(Io)		93.4	93.4	dB/Hz
Thermal D/L C/(No)		97.3	94.6	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location & Size:	New York	1.00		meter
Site Elevation Angle	40.8			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.70	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	150			W
Sat. Transmit Power	21.8			dBW
Sat. HPA Backoff	0.0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.6			dB
Sat Min. Ant. Gain	33.5			dBi
Total EIRP per beam	54.7			dBW
Operating EIRP/carrier		54.7	54.7	dBW
Space Loss		204.8	204.8	dB
Atm. (Gas + Cloud) Attenuation		0.2	0.2	dB
Rain Attenuation			0.9	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	39.4			dBi
System Noise Temp	91.6		137.7	°K
System Noise Temp	19.6		21.4	dBK
Station G/T		19.4	17.7	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		14.3	11.6	dB
Uplink Conditions	clear	rain	clear	
Downlink Conditions	clear	clear	rain	
U/L C/(No) (dB/Hz)	96.7	93.8	96.7	dB/Hz
U/L C/(Io) (dB/Hz)	97.1	97.1	97.1	dB/Hz
U/L C/(No+Io) (dB/Hz	93.9	92.1	93.9	dB/Hz
D/L C/(No) (dB/Hz)	97.3	97.3	94.6	dB/Hz
D/L C/(Io) (dB/Hz)	93.4	93.4	93.4	dB/Hz
D/L C/(No+Io) (dB/Hz	91.9	91.9	90.9	dB/Hz
Total C/(No+Io) (dB/Hz)	89.8	89.0	89.2	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	0.9	0.1	0.2	dB

Table A-3-a V-Band Link: Tokyo U/L to Honolulu D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat. Long. @ 155 deg East	**Clear**		**Rain**	**Units**
Terminal Location & Size:	**Tokyo**	**2.5**		meter
Site Elevation Angle	45.5			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.00	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off # of Amplified Carriers	2.5 10		0	dB
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		63.0	65.5	dBW
Space Loss		217.6	217.6	dB
Atm. (Gas + Cloud) Att.		4.2	4.4	dB
Rain Attenuation			7.3	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		12.6	7.7	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		98.0	98.0	dB/Hz
Thermal U/L C/(No)		95.7	90.7	dB/Hz
Total D/L C/I	15.4			dB
D/L C/(Io)		98.4	98.4	dB/Hz
Thermal D/L C/(No)		102.0	91.7	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		**Rain**	**Units**
Terminal Location & Size:	**Honolulu**	**2.50**		meter
Site Elevation Angle	31.9			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			99.00	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff # of Amplified Carriers	2.0 10			dB
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.4	216.4	dB
Atm. (Gas + Cloud) Attenuation		2.7	2.8	dB
Rain Attenuation			8.6	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.0			dBi
System Noise Temp	451.2		654.2	°K
System Noise Temp	26.5		28.2	dBK
Station G/T		31.0	29.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		19.0	8.7	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	95.7	90.7	95.7	dB/Hz
U/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
U/L C/(No+Io) (dB/Hz	93.6	89.9	93.6	dB/Hz
D/L C/(No) (dB/Hz)	102.0	100.7	91.7	dB/Hz
D/L C/(Io) (dB/Hz)	98.4	98.4	98.4	dB/Hz
D/L C/(No+Io) (dB/Hz	96.8	96.4	90.8	dB/Hz
Total C/(No+Io) (dB/Hz)	91.9	89.0	89.0	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	3.0	0.1	0.1	dB

Table A-3-b V-Band Link: Honolulu U/L to Seattle D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat. Long. @ -125 deg East	**Clear**		**Rain**	**Units**
Terminal Location & Size:	**Honolulu**	**2.5**		meter
Site Elevation Angle	45.4			deg
Site Altitude (ASL)	0.0			km
Frequency	48.7			GHz
Link Availability			99.00	%
Application Data Rate	155			Mbps
Station Transmitter Power	50.0			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off # of Amplified Carriers	2.5 10		0	dB
Station Transmitter Losses	1.0			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	59.5			dBi
Total EIRP per beam		73.0	75.5	
Operating EIRP per carrier		63.0	65.5	dBW
Space Loss		217.6	217.6	dB
Atm. (Gas + Cloud) Att.		3.8	3.8	dB
Rain Attenuation			7.5	dB
Pointing and Pol. Loss		0.5	0.5	dB
Sat. Antenna Gain	55.0			dBi
System Noise Temp	649.2			°K
System Noise Temp	28.1			dBK
Satellite G/T		26.4	26.4	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		13.1	8.0	dB
Total U/L C/I	15.0			dB
U/L C/(Io)		98.0	98.0	dB/Hz
Thermal U/L C/(No)		96.1	91.0	dB/Hz
Total D/L C/I	15.4			dB
D/L C/(Io)		98.4	98.4	dB/Hz
Thermal D/L C/(No)		103.1	91.3	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		88.9	88.9	dB/Hz

SUMMARY of Downlink Budget				
	Clear		**Rain**	**Units**
Terminal Location & Size:	**Seattle**	**2.50**		meter
Site Elevation Angle	35.2			deg
Site Altitude (ASL)	0.0			km
Frequency	41.0			GHz
Link Availability			99.88	%
Link Data Rate	155			Mbps
Satellite TWTA Rating	100			W
Sat. Transmit Power	20.0			dBW
Sat. HPA Backoff # of Amplified Carriers	2.0 10			dB
Transmitter Total losses	1			dB
Sat Min. Ant. Gain	55.0			dBi
Total EIRP per beam	72.0			dBW
Operating EIRP/carrier		62.0	62.0	dBW
Space Loss		216.3	216.3	dB
Atm. (Gas + Cloud) Attenuation		2.5	2.6	dB
Rain Attenuation			10.0	dB
User Ant. Pointing Losses		0.5	0.5	dB
Recvr. Antenna Gain	58.7			dBi
System Noise Temp	441.9		653.3	°K
System Noise Temp	26.5		28.2	dBK
Station G/T		31.8	30.1	dB/K
Boltzmann's Constant		-228.6	-228.6	dBW/K-Hz
Noise BW		83.0	83.0	dBHz
C/N (Thermal)		20.1	8.3	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	96.1	91.0	96.1	dB/Hz
U/L C/(Io) (dB/Hz)	98.0	98.0	98.0	dB/Hz
U/L C/(No+Io) (dB/Hz	93.9	90.2	93.9	dB/Hz
D/L C/(No) (dB/Hz)	103.1	102.0	91.3	dB/Hz
D/L C/(Io) (dB/Hz)	98.4	98.4	98.4	dB/Hz
D/L C/(No+Io) (dB/Hz	97.1	96.8	90.6	dB/Hz
Total C/(No+Io) (dB/Hz)	92.2	89.3	88.9	dB/Hz
Required C/No (dB/Hz)	88.9	88.9	88.9	dB/Hz
Margin (dB)	3.3	0.4	0.0	dB

Table A-4-a Ku-Band Link: Singapore U/L to Midway D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat.long. @ 155 deg East	Clear		Rain	Units
Terminal Location & Size:	**Singapore**	**2.5**		meter
Site Elevation Angle	31.1			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.40	%
Application Data Rate	**155**			Mbps
Station Transmitter Power	**100.0**			W
Transmitter Pwr (dBW)	20.0			dBW
Uplink Power Back-off	1.0		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	**48.8**			dBi
Total EIRP per beam		67.5	68.5	
Operating EIRP per carrier		**67.5**	**68.5**	dBW
Space Loss		**206.4**	**206.4**	dB
Atm. (Gas + Cloud) Att.		0.5	0.5	dB
Rain Attenuation			7.2	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	**33.5**			dBi
System Noise Temp	365.1			°K
System Noise Temp	**25.6**			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**13.1**	**6.9**	dB
Total U/L C/I	**16.6**			dB
U/L C/(Io)		**99.6**	**99.6**	dB/Hz
Thermal U/L C/(No)		**96.1**	**89.9**	dB/Hz
Total D/L C/I	**15.8**			dB
D/L C/(Io)		**98.8**	**98.8**	dB/Hz
Thermal D/L C/(No)		**105.5**	**100.6**	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		**88.9**	**88.9**	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location & Size:	**Midway**	**2.50**		meter
Site Elevation Angle	45.2			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.94	%
Link Data Rate	**155**			Mbps
Satellite TWTA Rating	**150**			W
Sat. Transmit Power	21.8			dBW
Sat. HPA Backoff	0.0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.6			dB
Sat Min. Ant. Gain	**33.5**			dBi
Total EIRP per beam	54.7			dBW
Operating EIRP/carrier		**54.7**	**54.7**	dBW
Space Loss		**204.7**	**204.7**	dB
Atm. (Gas + Cloud) Attenuation		**0.2**	**0.2**	dB
Rain Attenuation			**1.9**	dB
User Ant. Pointing Losses		**0.4**	**0.4**	dB
Recvr. Antenna Gain	**47.3**			dBi
System Noise Temp	89.0		174.8	°K
System Noise Temp	19.5		22.4	dBK
Station G/T		**27.5**	**24.6**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**22.5**	**17.6**	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	96.1	89.9	96.1	dB/Hz
U/L C/(Io) (dB/Hz)	99.6	99.6	99.6	dB/Hz
U/L C/(No+Io) (dB/Hz	**94.5**	**89.5**	**94.5**	dB/Hz
D/L C/(No) (dB/Hz)	105.5	103.8	100.6	dB/Hz
D/L C/(Io) (dB/Hz)	98.8	98.8	98.8	dB/Hz
D/L C/(No+Io) (dB/Hz	**97.9**	**97.6**	**96.6**	dB/Hz
Total C/(No+Io) (dB/Hz)	**92.9**	**88.9**	**92.4**	dB/Hz
Required C/No (dB/Hz)	**88.9**	**88.9**	**88.9**	dB/Hz
Margin (dB)	**4.0**	**0.0**	**3.5**	dB

Table A-4-b Ku-Band Link: Midway U/L to Seattle D/L - 2.5 m Terminals

SUMMARY of Uplink Budget				
Sat.long. @ -125 deg East	Clear		Rain	Units
Terminal Location & Size:	**Midway**	**2.5**		meter
Site Elevation Angle	24.6			deg
Site Altitude (ASL)	0.0			km
Frequency	13.0			GHz
Link Availability			99.92	%
Application Data Rate	**155**			Mbps
Station Transmitter Power	**50.0**			W
Transmitter Pwr (dBW)	17.0			dBW
Uplink Power Back-off	1.0		0	dB
# of Amplified Carriers	1			
Station Transmitter Losses	0.3			dB
Station Antenna Diameter	2.50			m
Station Peak Antenna Gain	**48.8**			dBi
Total EIRP per beam		64.5	65.5	
Operating EIRP per carrier		**64.5**	**65.5**	dBW
Space Loss		**206.6**	**206.6**	dB
Atm. (Gas + Cloud) Att.		0.4	0.4	dB
Rain Attenuation			3.9	dB
Pointing and Pol. Loss		0.4	0.4	dB
Sat. Antenna Gain	**33.5**			dBi
System Noise Temp	365.1			°K
System Noise Temp	**25.6**			dBK
Satellite G/T		7.4	7.4	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**10.1**	**7.2**	dB
Total U/L C/I	**16.1**			dB
U/L C/(Io)		**99.1**	**99.1**	dB/Hz
Thermal U/L C/(No)		**93.1**	**90.2**	dB/Hz
Total D/L C/I	**15.8**			dB
D/L C/(Io)		**98.8**	**98.8**	dB/Hz
Thermal D/L C/(No)		**105.1**	**95.7**	dB/Hz
Required Eb/No	6.5			dB
Effective Data Rate	174			Mbps
Data Rate (dB)	82.4			dB (bps)
Required C/(No+Io)		**88.9**	**88.9**	dB/Hz

SUMMARY of Downlink Budget				
	Clear		Rain	Units
Terminal Location & Size:	**Seattle**	**2.50**		meter
Site Elevation Angle	35.2			deg
Site Altitude (ASL)	0.0			km
Frequency	11.0			GHz
Link Availability			99.99	%
Link Data Rate	**155**			Mbps
Satellite TWTA Rating	**150**			W
Sat. Transmit Power	21.8			dBW
Sat. HPA Backoff	0.0			dB
# of Amplified Carriers	1			
Transmitter Total losses	0.6			dB
Sat Min. Ant. Gain	**33.5**			dBi
Total EIRP per beam	54.7			dBW
Operating EIRP/carrier		**54.7**	**54.7**	dBW
Space Loss		**204.9**	**204.9**	dB
Atm. (Gas + Cloud) Attenuation		0.2	0.2	dB
Rain Attenuation			5.0	dB
User Ant. Pointing Losses		0.4	0.4	dB
Recvr. Antenna Gain	**47.3**			dBi
System Noise Temp	91.4		257.1	°K
System Noise Temp	19.6		24.1	dBK
Station G/T		**27.4**	**22.9**	dB/K
Boltzmann's Constant		**-228.6**	**-228.6**	dBW/K-Hz
Noise BW		**83.0**	**83.0**	dBHz
C/N (Thermal)		**22.1**	**12.7**	dB
Uplink Conditions	**clear**	**rain**	**clear**	
Downlink Conditions	**clear**	**clear**	**rain**	
U/L C/(No) (dB/Hz)	93.1	90.2	93.1	dB/Hz
U/L C/(Io) (dB/Hz)	99.1	99.1	99.1	dB/Hz
U/L C/(No+Io) (dB/Hz	**92.1**	**89.6**	**92.1**	dB/Hz
D/L C/(No) (dB/Hz)	105.1	103.6	95.7	dB/Hz
D/L C/(Io) (dB/Hz)	98.8	98.8	98.8	dB/Hz
D/L C/(No+Io) (dB/Hz	**97.9**	**97.5**	**93.9**	dB/Hz
Total C/(No+Io) (dB/Hz)	**91.1**	**89.0**	**89.9**	dB/Hz
Required C/No (dB/Hz)	**88.9**	**88.9**	**88.9**	dB/Hz
Margin (dB)	**2.2**	**0.1**	**1.0**	dB

Table A-5. Ku-Band Telemetry Link

Parameter	Spot Antenna	Omni Pipe	Comments
Minimum EIRP, dBW	8.0	0.0	Estimate
Path Loss, dB/m^{-2}	-162.5	-162.5	40° elevation
Atmospheric Absorption, dB	-0.2	-0.2	Estimate; clear sky
Isotropic Area, $dB\text{-}m^2$	-42.0	-42.0	10700 MHz
Ground Station G/T, dB/°K	34.2	34.2	7-m antenna
Tracking Loss	-0.1	-0.1	
Polarization Mismatch, dB	-0.1	-0.1	
Boltzmann's Constant, dBW/°K-Hz	-228.6	-228.6	
Downlink C/No. @ TM Receiver, dB-Hz	65.8	57.8	
Minimum C/No @ TM Receiver, dB-Hz	53.0	53.0	For 4 Kbps stream
Clear Weather C/No Margin, dB	12.8	4.8	1.0 dB rain fade for 99.95% availability
S/No Computation for Ranging:			
Demodulation Factor, dB	-5.2	-5.2	when carrier is at minimum
Receiver Baseband S/No, dB-Hz	60.6	52.6	modulation index
Carrier Recovery:			
TM Receiver Loop Bandwidth, dB-Hz	40.0	40.0	10 kHz PM demod PLL BW
Carrier Power Factor, dB	-3.2	-3.2	when carrier is at maximum
Margin, dB	16.7	8.7	modulation index
Subcarrier Recovery:			
TM Receiver IF Bandwidth, dB-Hz	57.0	57.0	500 kHz BW
Subcarrier Power Factor, dB	-5.2	-5.2	when carrier is at minimum
Margin, dB	18.6	10.6	modulation index
BER Computation:			
Demodulation Factor, dB	-5.2	-5.2	
Implementation Loss, dB	-2.5	-2.5	
Margin, dB	11.6	3.6	for 10^{-6} bit error rate

Table A-6. Ku-Band Command Links

SpaceCast Ku-band On-station Planar Array Command Link Budget		
Contribution	Value	Comment
Max Ground Station EIRP, dBW	83.8	7-m antenna
Tracking Error Ground Station, dB	-0.2	
Path Loss, dB-m^2	-162.5	40° elevation
Clear Sky Loss, dB	-0.3	
Isotropic Area, dB-m^2	-43.6	12750 MHz
BTA Gain (Sum Path), dB	34.7	USDBS
Polarization Loss, dB	-0.1	
Path Loss to CR, dB	-16.3	Ku-band; includes SSMA
Power at Cmd Rcvr input, dBW	-104.5	
Command Receiver Threshold, dBW	-135.0	
Command Margin, dB	36.4	
Rain Fade, dB	1.3	99.95% availability
Command Margin with Rain Fade, dB	34.1	
SpaceCast Ku-band On-station Pipe Command Link Budget		
Contribution	Value	Comment
Max Ground Station EIRP, dBW	83.8	7-m antenna
Tracking Error Ground Station, dB	-0.2	
Path Loss, dB-m^2	-162.5	40° elevation
Clear Sky Loss, dB	-0.3	
Isotropic Area, dB-m^2	-43.6	12750 MHz
BTA Gain (Sum Path), dB	3.7	On-axis (Ku-band)
Polarization Loss, dB	-3.0	Linear Transmit to Circular Receive
Path Loss to CR, dB	-6.3	
Power at Cmd Rcvr input, dBW	-128.4	Ku-band; includes SSMA
Command Receiver Threshold, dBW	-135.0	
Command Margin, dB	6.6	
Rain Fade, dB	1.3	99.95% availability
Command Margin with Rain Fade, dB	5.3	

Appendix B
Interference Analysis

APPENDIX B: INTERFERENCE ANALYSIS

This appendix presents C/I interference analyses and their results for scenarios involving SpaceCast™ and hypothetical GSO FSS systems.

A C/I analysis was performed to determine whether SpaceCast™ could share spectrum with a hypothetical GSO FSS system operating at V-band, referred to here as System-X. In scenario #1, the interfered-with satellite is System-X, which has the same parameters as a SpaceCast™ satellite. The C/I for scenario #1 is given in Table B-1. Parameters for interference analyses of this type are listed in Table B-3 for the uplink, and in Table B-4 for the downlink. In this type of scenario, a SpaceCast™ satellite and a System-X satellite are spaced 2° apart on the geostationary arc. This is approximately equivalent to a topographic angle of 2.2°. The interference budget for scenario #1 is shown in Table B-7. It shows that, at V-band, SpaceCast™ can operate 2° away from a similar system without harmfully interfering with it.

The interference budget for the reverse scenario, where System-X interferes with a SpaceCast™ satellite, is shown in Table B-9. Again, System-X has the parameters of a SpaceCast™ satellite. The two satellites are spaced 2° apart on the geostationary arc. The resulting C/I shows that, at V-band, SpaceCast™ can operate 2° away from a similar system without being harmfully interfered with.

Also, a C/I analysis was performed to determine whether SpaceCast™ could share spectrum with Expressway™. Expressway™ is a proposed GSO FSS system, which would operate in the same frequency bands as SpaceCast™. The parameters for this system are listed in Table B-3 for the uplink, and in Table B-4 for the

downlink. First, the C/I for a SpaceCast™ satellite interfering with an Expressway™ satellite is calculated and listed under scenario #2 in Table B-1. The interference budget for this is given in Table B-8. Then, the C/I for the worst case interference, a scenario where an Expressway™ satellite interferes with a SpaceCast™ satellite, is calculated and given as scenario #4. The interference budget for scenario #4 is shown in Table B-10. In scenarios #2 and #4 in Table B-1, the two satellites are spaced 2° apart on the geostationary arc. Again, this is approximately equivalent to a topographic angle of 2.2°. The C/I results show that, for V-band operations, Expressway™ and SpaceCast™ are compatible when spaced 2° apart.

C/I analyses were also performed to determine whether SpaceCast™ could share spectrum with a hypothetical GSO FSS system operating at Ku-band, referred to here as System-Y. System-Y has earth station and space station characteristics derived from typical Ku-band satellite systems. The System-Y transponder bandwidth is assumed to be 30 MHz for satellite television signal transmissions. In interference scenarios, a SpaceCast™ satellite and a System-Y satellite are spaced 2° apart on the geostationary arc. The worst case scenario for SpaceCast™ interfering with System-Y is listed as scenario #5 in Table B-2. The worst case scenario for the reverse scenario, where System-Y interferes with SpaceCast™, is listed as scenario #7 in Table B-2. The parameters for SpaceCast™ and System-Y are given in Tables B-5 and B-6. The C/I results show that SpaceCast™ and a typical Ku-band system can operate spaced 2° apart without causing or receiving harmful interference.

Finally, C/I analyses were performed to determine whether SpaceCast™ could share spectrum with the Ku-band portion of Expressway™. In the